Viewpoint ■

Integrating Medical Informatics and Health Services Research:

The Need for Dual Training at the Clinical Health Systems and Policy Levels

KENNETH D. MANDL, MD, MPH, THOMAS H. LEE, MD, MSC

Abstract Reams of data pertaining directly to the core health services research mission are accumulating in large-scale organizational and clinical information systems. Health services researchers who grasp the structure of information systems and databases and the function of software applications can use existing data more effectively, assist in establishing new databases, and develop new tools to survey populations and collect data. At the same time, informaticians are needed who can structure databases that serve the needs of health service research and who can design and evaluate applications that effectively improve health care delivery. As long as health services researchers and informaticians work in separate spheres, however, opportunities to use data from health care encounters to improve care, expand knowledge, and develop more effective policies will be missed. This paper provides a brief exploration of 1) existing successful collaborations between health services researchers and informaticians and 2) needs and opportunities for additional joint work in several core research areas.

■ **J Am Med Inform Assoc.** 2002;9:127–132.

In the 1970s, the health services researcher* managed data on tapes, rented valuable and scarce CPU time on a mainframe computer, and often required the assistance of a programmer. By the early 1990s, the health services researcher had been freed, able to harness the power of desktop computers running database and statistical programs and, for nominal fees, having access to myriad publicly available secondary data sets on CDs, such as the National Health and Nutrition Examination Survey. Schools of public health and other training programs in clinical and health services research began to systematically teach the skills necessary to analyze these data.

Today, reams of data pertaining directly to the core health services research mission are accumulating in large-scale organizational and clinical information systems. Health services researchers who grasp the structure of information systems and databases and the function of software applications can use existing data more effectively, assist in establishing new databases, and develop new tools to survey populations and collect data. At the same time, informaticians are needed who can structure databases that serve the needs of health service research and who can design and evaluate applications that effectively improve health care delivery. As long as health services researchers and informaticians work in separate spheres, however, opportunities to use data from health care encounters to improve care, expand knowledge, and develop more effective policies will be missed.

Affiliations of the authors: Children's Hospital, Boston, Massachusetts (KDM); Partners Community Healthcare, Harvard Medical School, Boston, Massachusetts (THL).

Correspondence and reprints: Kenneth D. Mandl, MPH, Division of Emergency Medicine, Children's Hospital Boston, 300 Longwood Avenue, Boston, MA 02115; e-mail: <kenneth_mandl@harvard.edu>.

Received for publication: 5/27/01; accepted for publication: 11/20/01.

**Health services research* is used in a broad definition that includes public health research, epidemiology, and clinical research (see Table 1).

The Gap

Given the obvious opportunities for fruitful collaboration between health services research and informatics, why doesn't it happen more frequently? First, not enough researchers—"bridge" researchers—are trained in both fields. Collaboration can be difficult when informaticians and health services researchers come together without the participation of bridge researchers, who are familiar with both disciplines. Often, communication is impeded by the lack of a common theoretic framework or vocabulary. Also, the gap is physical—health services researchers and informaticians often do not work near each other. Even when informatics and health services research programs exist in the same institutions, activities are often carried out separately. The physical separation results in a paucity of communication. In some institutions, this physical separation is reinforced by the perception that informaticians are "operations" personnel, whereas health services researchers are academic in orientation.

A disparity in approach to problems is another barrier to collaboration. Software development is an engineering process, whereas health services research and technology evaluation seek proof of effectiveness and economy. Understanding whether information systems are effective in health care delivery requires well-designed evaluations. Stead et al.[1] provide a framework for incorporating evaluation into a staged system development. Not all informatics training programs, however, equip their graduates with the tools to implement these evaluations. The better part of the informatics literature consists of articles describing bench testing of systems in various stages of development.[2] Studies evaluating an information system when it is in routine operational use can occur only in the last stages of an often long development cycle. As more systems reach this stage, it will be especially important for informaticians to have the skills and knowledge to launch evaluations of the impact of technologic innovations on individuals, populations, and organizations.

Health services researchers have traditionally relied on medical claims data for their analyses; until recently, claims data were the only comprehensive data sets available. Now, other data sources have emerged, and tools from informatics are necessary to access them. Health services researchers beginning to use informatics-based tools in their work often do not select appropriate technologies, construct robust data models, use standardized vocabularies, or program efficiently. Health services researchers are often ill prepared to specify the technical features of a piece of software to be developed. Again, training programs in health services research, such as Master of Public Health degree programs, rarely teach these skills. Although institutional data repositories provide rich clinical data sources, traditional health services research training does not include design, manipulation, and analysis of large relational databases.

Training that bridges the gap between these two disciplines will make students familiar with the language and concepts of both fields. These researchers will be in a position to lead multidisciplinary efforts more productively and efficiently.

Core Research Areas

A brief exploration of 1) existing successful collaborations between health services researchers and informaticians and 2) needs and opportunities for additional joint work in several core research areas informs the discussion of what base of knowledge bridge researchers should have (Table 1).

Table 1 ■

Definitions

Medical informatics is "the field that concerns itself with the cognitive, information processing, and communication tasks of medical practice, education, and research, including the information science and the technology to support these tasks."[25]

Health services research is "the multidisciplinary field of scientific investigation that studies how social factors, financing systems, organizational structures and processes, health technologies, and personal behaviors affect access to health care, the quality and cost of health care, and ultimately our health and well-being. Its research domains are individuals, families, organizations, institutions, communities and populations."[26]

Public health research addresses the mission of public health which is to is to "fulfill society's interest in assuring conditions in which people can be healthy."[27]

Epidemiology is ""the study of the distribution and determinants of health-related states in specified populations, and the application of this study to control of health problems."[28]

Clinical research is "conducted with human subjects (or on material of human origin such as tissues, specimens and cognitive phenomena) for which an investigator (or colleague) directly interacts with human subjects. This area of research includes: mechanisms of human disease, therapeutic interventions, clinical trials, and development of new technologies."[29]

Electronic Medical Records

The electronic medical record has been referred to as the holy grail of medical informatics. Clinicians, health systems administrators, and policy makers would all benefit from having an electronic record that can capture data along the entire continuum of care. Such records would also be tremendous assets for health services research. Currently, the medical records of most patients are fragmented across multiple treatment sites, posing an obstacle to clinical care, research, and public health efforts.[3] Even in a single care site that lacks electronic records, the data generated during the course of care are largely inaccessible for health services research, since reviewing and abstracting paper charts is so labor intensive. Electronic medical records afford a technical infrastructure on which longitudinal medical records can be built. These can then be integrated across sites of care[4] and tapped by health services researchers and those involved in quality improvement efforts.

Choices about the structure and content of these records will have a profound effect on the accessibility and privacy of patient information. The records will only be sharable if they adhere to standards—standard vocabularies such LOINC and SNOMED, standard messaging formats such as HL7, and standard formats for image exchange such as DICOM.[5] Health services researchers, health systems administrators, and public health officials must become educated about these standards and make a commitment to adhere to them. Record systems must be implemented with proper security measures to protect patient privacy.[4] Robust data models are needed to ensure scalability of the systems and accessibility of the data. It has become apparent that waiting for industry to solve these problems may not be realistic. Rather, an electronic medical record that supports a full range of health care, quality assessment, and research needs is likely to emerge only through cooperative research and development efforts involving both informaticians and health services researchers.

New Approaches to Health Services Research

An important impetus for a fusion of health services research and informatics comes from increasing sophistication about the measurement of quality in health care and the development of new types of "customers" for information about health care quality, including consumers, payers, employers, and health care providers.

The health care marketplace is increasingly interested in data on patient satisfaction, efficiency, and the use of scientific evidence in medical practice. Organizations often use such data without insight from health services researchers on how to adjust for trends and confounders. Provider organizations trying to negotiate contracts are hindered by lack of "real time" data on the severity of illness of their current patient population or approaches to estimating which of their patients are most likely to become catastrophically ill in the next year.

A decade ago, health services researchers might have focused only on questions such as whether a mammogram or influenza vaccination had been performed. Today, an increasing number of measures require the use of clinical data that cannot be obtained from claims data. Examples include new HEDIS (Health Plan Employer Data and Information Set) measures from the National Committee for Quality Assurance, such as measurement of low-density lipoprotein cholesterol levels for patients with known coronary disease or the percentage of patients with hypertension who meet criteria for "controlled."

At the clinical level, powerful information systems can enhance efforts to improve quality, reduce errors, and conduct research by collecting accurate and complete information from physicians and delivering such information back to them in usable formats. Health services researchers and informaticians have measured substantial improvements in the rate of serious inpatient medication errors with implementation of effective clinical information systems.[7] An automated outpatient reminder system improved the rate of delivery of preventive services in a clinic,[8] demonstrating the success of a collaborative approach to choosing and solving a health services research problem with information technology. Another such success came about in the area of clinical decision support. Intermountain Health Care implemented a clinical decision support system to help physicians choose antibiotics for patients in intensive care.[9] The program reduced errors and improved therapeutic choices.

Informaticians are beginning to guide health services researchers in establishing data repositories and implementing appropriate data models to support large-scale health service research projects, such as the Nurses' Health Study. The input of informaticians has been invaluable in beginning to solve large-scale health services research problems. One such example is immunization tracking,[10] a problem for clinicians, practices, health systems and public health

officials. With immunization tracking systems, policy makers will have data about what programs are effective in improving immunization rates.

The most tangible evidence for the viability of a fusion of health services research and medical informatics is the fact that some delivery systems now employ health services researchers to develop interventions and to measure their effects. In addition, provider organizations and insurance companies are increasingly employing physician medical directors whose strength is understanding both methods of health services research and medical informatics. New directions in research on quality[11] and cost effectiveness[12] become possible.

An unpublished study of such an initiative was the analysis of variations within the network in severity of illness and resource use for negotiation of capitated "risk" contracts at Partners Health Care (an integrated delivery system of community and academic physicians). This project relied on health services research methods and on data obtained with the tools of informatics. These analyses have been used to structure different types of contractual relationships that help protect physicians from the financial consequences of adverse selection. In addition, these analyses can be used to shift funds internally within a health system.

Consumer Health

Over the past 5 years, it has become increasingly clear that information technology will allow unprecedented advances in health care through leveraging of a previously untapped resource—the patient. Applications have been deployed that affect change at the point of care and provide decision support-both for patients[13] and physicians.[14] Doctors and their patients are exploring the use of electronic mail in the medical context.[15–17] Patients seek health information on the Internet.[18,19] New approaches to medical record systems put the patient in control of the record.[6,20]

Telemedicine may improve health services delivery to consumers as well. In one application, for example, the parents of premature infants videoconference from home with a neonatal intensive care unit.[21] As such interventions are implemented, health services researchers should be evaluating their effects on resource use, satisfaction, and technical quality of care. Bridge researchers are needed to keep applications secure and to choose areas for intervention that will maximize the cost effectiveness of new technologies.

Public Health Surveillance

An infrastructure to support fundamental change in the health care system must include real-time information about regional disease patterns and health care processes. Current health information systems fall far short of this capability,[22] despite readily available information technology to process patient data. A recent focus on preparedness for bioterrorism, which has been sharpened in light of recent events, has thrown into greater relief the problems we face in the absence of real-time information.[23] Few surveillance systems are automated. They currently rely on manual reporting by overburdened clinicians.

Table 2 ■

Knowledge Base
Access and equity for patient populations
Applications design
Artificial intelligence machine learning
Automated decision support
Biostatistics
Clinical practice guidelines
Clinical trials
Computer architecture
Computer networking
Computer programming
Cost-effectiveness analysis
Database design and administration
Data modeling
Decision analysis
Decision support
Electronic communication and messaging
Epidemiology
Hospital administration
Medical vocabularies
Operations research
Outcomes research
Program evaluation
Programming (JAVA and other languages)
Quality improvement
Scientific writing
Security architecture and policy
Study design
Surveillance methods
Survey design
Systems integration
Technology assessment
Telemedicine technologies
Web site design

Small-area geographic variations in risks or outcomes are difficult to analyze. A major effort under way at the Centers for Disease Control is the National Electronic Disease Surveillance System (NEDSS).[24] The goals of NEDSS are to enhance public health surveillance through integration of surveillance systems and direct electronic communications between sources of data using well-defined standards. NEDSS is working with HL7 and LOINC developers to establish reporting standards and is beginning to establish electronic connections between laboratories and public health departments.

Future Directions

Both health services research and medical informatics have much to gain from active cultivation of the interface between these two disciplines. Health services researchers can gain access to a wealth of tools, data, and analytic methods. Medical informaticians can get help developing new interventions and measuring the effects of those efforts and other health care processes.

A logical next step would be a needs assessment to estimate workforce requirements. Departments of medical informatics should consider developing close relationships with, or even hiring, health services researchers, and vice versa.[30] Two broad approaches to bridging the gap between health services research and medical informatics research are to 1) encourage cross-hybridization at existing training programs with health services research and informatics faculty in close proximity, as well as creating new such programs, and 2) encourage and fund research and researchers at the gap.[31] Bridge researchers need to have a core knowledge base to tackle the challenges of designing electronic medical records, developing new approaches to health services research, building consumer health, and implementing a nationwide public health surveillance infrastructure (Table 2). Providing training and research opportunities will foster the development of investigators able to capitalize on large data sets and deploy 21st century tools that enhance research, public health, and health care.

References ■

1. Stead WW, Haynes RB, Fuller S, et al. Designing medical informatics research and library: resource projects to increase what is learned. J Am Med Inform Assoc. 1994;1(1):28–33.
2. Stead W. Matching the level of evaluation to a project's stage of development. J Am Med Inform Assoc. 1996;3(1):92–4.
3. Computer Science and Telecommunications Board, National Research Council. Networking Health. Washington, DC: National Academy Press, 2000.
4. Computer Science and Telecommunications Board, National Research Council. For the Record: Protecting Electronic Health Information. Washington, DC: National Academy Press, 1997.
5. McDonald CJ. The barriers to electronic medical record systems and how to overcome them.J Am Med Inform Assoc. 1997;4(3):213–21.
6. Committee on Quality of Health Care in America, Institute of Medicine. Crossing the Quality Chasm: A New Health System for the 21st Century. Washington, DC: National Academy Press, 2001.
7. Bates DW, Leape LL, Cullen DJ, et al. Effect of computerized physician order entry and a team intervention on prevention of serious medication errors. JAMA. 1998;280(15):1311–6.
8. Dexter PR, Perkins S, Overhage JM, Maharry K, Kohler RB, McDonald CJ. A computerized reminder system to increase the use of preventive care for hospitalized patients. N Engl J Med. 2001;345(13):965–70.
9. Evans RS, Pestotnik SL, Classen DC, et al. A computer-assisted management program for antibiotics and other anti-infective agents. N Engl J Med. 1998;338(4):232–8.
10. Miller PL, Frawley SJ, Sayward FG. Informatics issues in the national dissemination of a computer-based clinical guideline: a case study in childhood immunization. Proc AMIA Annu Symp. 2000:580–4.
11. Pearson SD, Kleefield SF, Soukop JR, Cook EF, Lee TH. Critical pathways intervention to reduce length of hospital stay. Am J Med. 2001;110(3):175–80.
12. Hickey ML, Cook EF, Rossi LP, et al. Effect of case managers with a general medical patient population. J Eval Clin Pract. 2000;6(1):23–9.
13. Gustafson DH, Hawkins R, Boberg E, et al. Impact of a patient-centered, computer-based health information/support system. Am J Prev Med. 1999;16(1):1–9.
14. Durieux P, Nizard R, Ravaud P, Mounier N, Lepage E. A clinical decision support system for prevention of venous thromboembolism: effect on physician behavior. JAMA. 2000;283(21):2816–21.
15. Kane B, Sands DZ. Guidelines for the clinical use of electronic mail with patients. The AMIA Internet Working Group, Task Force on Guidelines for the Use of Clinic-Patient Electronic Mail. J Am Med Inform Assoc. 1998;5(1):104–11.
16. Robinson TN, Patrick K, Eng TR, Gustafson D. An evidence-based approach to interactive health communication: a challenge to medicine in the information age. Science Panel on Interactive Communication and Health. JAMA. 1998;280(14):1264–9.
17. Balas EA, Jaffrey F, Kuperman GJ, et al. Electronic communication with patients: evaluation of distance medicine technology. JAMA. 1997;278(2):152–9.
18. Berland GK, Elliott MN, Morales LS, et al. Health information on the Internet: accessibility, quality, and readability in English and Spanish. JAMA. 2001;285(20):2612–21.
19. Winker MA, Flanagin A, Chi-Lum B, et al. Guidelines for medical and health information sites on the Internet: principles governing AMA Web sites. American Medical Association. JAMA. 2000;283(12):1600–6.
20. Mandl KD, Szolovits P, Kohane IS. Public standards and patients' control: how to keep electronic medical records accessible but private. BMJ. 2001;322(7281):283-7.
21. Gray JE, Safran C, Davis RB, et al. Baby CareLink: using the Internet and telemedicine to improve care for high-risk infants. Pediatrics. 2000;106(6):1318–24.
22. Fernandez F. Statement before the Subcommittee on Emerging Threats and Capabilities, Committee on Armed Services,

United States Senate. Apr 20, 1999. Washington, DC: Defense Advanced Research Projects Agency, 1999.
23. Henderson DA. The looming threat of bioterrorism. Science. 1999;283(5406):1279–82.
24. Centers for Disease Control. Updated guidelines for evaluating public health surveillance systems. MMWR Morbid Mortal Wkly Rep. 2000;50(RR13):1–35.
25. Greenes RA, Shortliffe EH. Medical informatics: an emerging academic discipline and institutional priority. JAMA. 1990;263 (8):1114–20.
26. Academy for Health Services Research and Health Policy. Glossary of terms commonly used in health care. AHSRHP Web site. 2001. Available at: http://academyhealth.org/publications/glossary-healthcare.htm#h. Accessed Nov 22, 2001.
27. Institute of Medicine. The Future of Public Health. Washington, DC: National Academy Press, 1988.
28. Last J. A Dictionary of Epidemiology. 2nd ed. Oxford, UK: Oxford University Press, 1988.
29. The National Institutes of Health Director's Panel on Clinical Research. Report to the Advisory Committee to the NIH Director. 1997. NIH Web site. Available at: http://www.nih.gov/news/crp/97report/execsum.htm#2define. Accessed Oct 9, 2001.
30. Shortliffe EH, Garber AM. Training synergies between medical informatics and health services research: successes and challenges. J Am Med Inform Assoc. 2002;9:133–9.
31. Corn et al. Bridging the gap in medical informatics and health services research: workshop results and next steps. J Am Med Inform Assoc. 2002;9:140–3.